Docket No.: 1509-218

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

jc997 U.S. PTO
09/955223
09/19/01

In re Application of	:	
Simon RICHES et al.	:	
Serial No. Not yet assigned	:	Group Art Unit: Not yet assigned
Filed: herewith	:	Examiner: N/A

For: IMPROVEMENTS IN AND RELATING TO DATA PROTECTION

CLAIM OF PRIORITY AND TRANSMITTAL OF CERTIFIED PRIORITY DOCUMENT

Assistant Commissioner For Patents
Washington, D.C. 20231

Dear Sir:

In accordance with the provisions of 35 U.S.C. 119, Applicant hereby claims the priority of:

United Kingdom Patent Application No. 0023048.2 filed September 20, 2000

cited in the Declaration of the present application.

The certified copy is submitted herewith.

Respectfully submitted,

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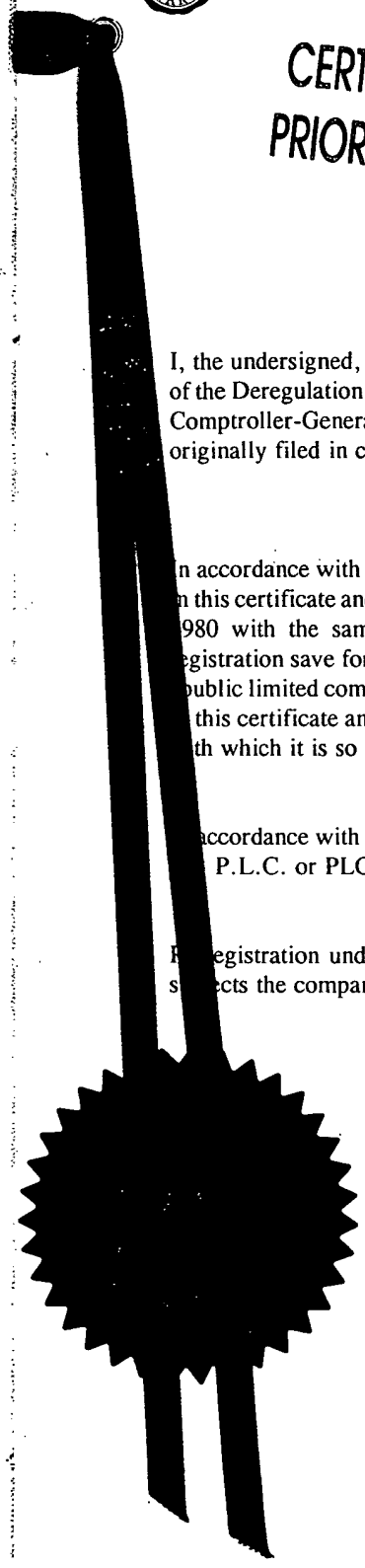

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Cardiff Road
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1. Your reference

   30001070 GB

2. Patent application number
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   0023048.2

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

   Hewlett-Packard Company
   3000 Hanover Street
   Palo Alto
   CA 94304, USA

   Patents ADP number *(if you know it)*

   If the applicant is a corporate body, give the country/state of its incorporation

   Delaware, USA

   4965886004

4. Title of the invention

   Improvements in and relating to data protection

5. Name of your agent *(if you have one)*

   "Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

   Matthew Lawman
   Hewlett-Packard Ltd, IP Section
   Filton Road
   Stoke Gifford
   Bristol BS34 8QZ

   7563083001

   Patents ADP number *(if you know it)*

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Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application	Date of filing *(day / month / year)*

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:*

   a) any applicant named in part 3 is not an inventor, or
   b) there is an inventor who is not named as an applicant, or
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11. I/We request the grant of a patent on the basis of this application.

Signature M. J. Lawman Date 18/9/00

Matthew J M Lawman

12. Name and daytime telephone number of person to contact in the United Kingdom

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DUPLICATE

IMPROVEMENTS IN AND RELATING TO DATA PROTECTION

The present invention relates to the protection of data recorded on a data storage tape.

Such a data storage tape is typically a magnetic tape wound on one or a pair of reels within a casing, the whole being referred to as a "tape data storage cartridge".

Many data processing applications require back-up data to be held on storage medium such as magnetic tape. There is a need for such stored data to be protected against unauthorised amendments, additions or general tampering. The present invention finds particular though not exclusive applicability in specific environments, for example bank transaction records archives (Securities Exchange Commission (SEC) requirement), security records and the like.

It is an aim of embodiments of the present invention to provide data protection for data stored on a data storage tape.

According to a first aspect of the present invention there is provided a method of protecting data during writing of the data to a data storage tape, the method including the steps of:-

writing a data set to the tape and creating a code representative of the content of the data set being written to the tape, and

associating said code with said data set.

Preferably, the method includes the step of storing the code. More preferably, the code is stored by being written as an entry to a memory.

Preferably the code is associated with the data set by allocating an identification symbol to said code.

Preferably, said identification symbol is also written to the memory.

Preferably, the memory is incorporated within a memory device. Such a memory device may be physically associated with the tape, for example within the cartridge casing, and is preferably arranged such that it can be read and written to by inductive coupling.

Alternatively the memory may be a dedicated area of tape set aside for this purpose. The setting aside of a dedicated area of tape is known to those skilled in the art.

Preferably, the method includes repeating at least said data writing and code-with-data set associating steps to produce on the tape a number of data sets, each having a unique code associated with that particular data set.

Preferably, each access to the tape (irrespective of the nature of the data to be written) is treated as a new data set.

Preferably, the identification symbol is simply the number corresponding to the position of a particular code entry

within a sequence of such code entries (i.e. the 3rd entry in a sequence of 16 entries.

Thus, each code entry corresponds to a distinct storage session on the tape.

Preferably, the method includes the further steps of:

reading back a data set from the tape and creating a further code representative of the content of the data set read back from the tape,

comparing the two codes and confirming the data set as valid only if the two codes agree.

The comparing and/or confirming steps may be carried out by the controlling software application, or alternatively may be carried out by means of, for example, an external reader which is able to access and/or display information recorded in the memory.

Preferably, at least the codes created during writing of the data sets to the tape are written as entries to a table in the memory device, in which each entry is identified by its position within the table.

Preferably, said code is a signature.

Alternatively said code is a checksum or CRC (cyclic redundancy check).

The code creating steps may be carried out by apparatus used to write to and/or read from the tape (for example a

tape drive), or alternatively they may be carried out by a controlling software application using existing code creation software.

Preferably, the tape is magnetic tape and more preferably is an implementation of Linear Tape-Open (LTO) technology, either single reel or dual reel.

Preferably, the memory device includes a memory area (for example an electrically erasable programmable read only memory or EEPROM) and a transponder comprising a transmitter, a receiver, an aerial, a processor and a crystal oscillator. The transponder of the memory device is powered by and exchanges information with a reader/writer device for reading data from and writing data to the memory device, via a contactless (inductively coupled) interface. The reader/writer device is typically incorporated within the tape drive such that when the tape cartridge is inserted into the tape drive the memory device is powered inductively and data signals can be sent and received via said interface. Such a memory device is hereinafter referred to as a "cartridge memory".

Such a cartridge memory is currently provided with LTO tape cartridges, which can store and retrieve a tape cartridge's historical usage and other information which can then be interrogated without the need for any physical contact between the tape and tape reader. Such a cartridge memory is an embedded electronics and interface module.

Conveniently, said identification symbol is numeric.

Preferably, said identification symbol is an integer.

Preferably, each time a data set is written to the tape and a corresponding associated code is written to the memory, the next code representative of the next data set is entered as the next entry to the memory, for example by incrementing a code counter by 1 in the case where the identification symbols are integers 0, 1, 2, 3, 4, 5... etc.

Preferably, the method includes the step of keeping count of the total number of codes written to the memory device, that is to say the total number of entries made to the table in the memory.

Preferably, the method includes the step of checking whether or not a predetermined number of entries has been exceeded, and if it has, reporting the tape as read only.

Preferably, said predetermined number of entries is 16.

Preferably, said identification symbol is an integer of between 0 and 15.

Conveniently, the method further includes the steps of:-

comparing the associated code with information held on a secure database, and

confirming the tape and/or the data contained thereon as valid only if the code and its association with a particular data set agree with the information held on the secure database.

Such a secure database may, for example, be a database containing a table of values which is an exact mirror of the contents of the memory device for each particular section of tape. The secure database preferably can only have additional entries written to it until the maximum number of entries for that section of tape has been reached. All other accesses to the secure database are read only, such that the entries thereto cannot be overwritten.

Again, the comparing and/or confirming steps may be carried out by the controlling software application, or alternatively may be carried out by means of, for example an external reader.

Such an external reader preferably comprises an apparatus having a port arranged to locate a tape cartridge therein, a display device such as a liquid crystal display, a user input interface in the form of a keypad, a battery or other power supply, a receiver device in or near the cartridge port for communicating with a cartridge memory, and an external port for connecting to an external computer or processor.

Preferably, said information held on the secure database includes a secure copy of the code. Such a secure copy may, for example, be a read-only exact mirror of the contents of the memory.

In the preferred embodiment where steps a) to c) are repeated to produce a number of data sets, the storage medium would be confirmed as valid only if all of the

codes and their associations agree with the information on the secure database.

By carrying out the comparing and confirming steps by means of external hardware, such as an external reader, the tape cartridge does not have to be inserted into a tape drive in order to confirm the validity of the tape and/or the data contained thereon.

Therefore, the method of the present invention has as a particular advantage the ability to confirm the validity of for example a tape and/or the data on the tape, without the need for a tape drive.

According to a second aspect of the present invention there is provided a method of protecting data during writing of the data to and reading of the data from a data storage tape, the method including the steps of:-

writing a data set to the tape and creating a first code representative of the content of the data set being written to the tape,

associating said first code with said data set,

reading back a data set from the tape and creating a second code representative of the content of the data read back from the tape, and

comparing the first and second codes and confirming the data set as valid only if the two codes agree.

Preferably, the method includes the step of storing the code. More preferably, the code is stored by being written as an entry to a memory device.

According to a third aspect of the present invention there is provided a method of protecting data during writing of the data to a data storage tape, the method including the steps of:

writing a data set to the tape and creating a code representative of the content of the data set being written to the tape,

associating the code with the data set,

comparing the associated code with information held on a secure database, and

confirming the tape and/or the data contained thereon as valid only if the code and its association with a particular data set agree with the information held on the secure database.

Preferably, the method includes the step of storing the code. More preferably, the code is stored by being written as an entry to the memory device.

According to a fourth aspect of the present invention there is provided a data storage tape having recorded thereon at least one data set, wherein said data set has associated therewith a code representative of the content of said data set.

Preferably the code is stored as an entry to a memory.

According to a fifth aspect of the present invention there is provided a data storage tape arranged such that a data set recorded therein may be associated with a code representative of the content of said data set.

Preferably, the code is associated with a particular data set by means of an identification symbol.

Preferably the identification symbol is also stored in the memory.

Preferably, the memory is incorporated within a memory device. Such a memory device may be physically associated with the tape, for example within the cartridge casing, and is preferably arranged such that it can be read and written to by inductive coupling.

Alternatively the memory may be a dedicated area of tape set aside for this purpose.

Preferably, the memory device has stored therein a number of codes, each representative of a particular one of a number of data sets on the tape and identifiable as associated with that particular data set.

Preferably, the codes are written as entries to a table in the memory device, in which each entry is identifiable by means of its position within the table.

Preferably, the code is a signature. Alternatively, the code may be a checksum or CRC (cyclic redundancy check).

Preferably, the memory device is a cartridge memory.

Preferably, the identification symbol is numeric, more preferably it is an integer, and even more preferably an integer between 0 and 15.

Preferably, the memory device includes a counter which indicates the number of codes entered.

For a better understanding of the invention, and to show how embodiments of the same may be carried into effect, reference will now be made, by way of example, to the accompanying diagrammatic drawings in which:

Figure 1 is a schematic layout of the tape drive and controlling software application;

Figure 2 illustrates initialisation of the signature counter;

Figure 3 illustrates the first signature entry being made;

Figure 4 illustrates the tenth signature entry being made;

Figure 5 illustrates the procedural steps carried out during a back-up operation;

Figure 6 illustrates the procedural steps carried out during a restore or validation operation;

Figure 7 illustrates a tape data storage cartridge;

Figure 8 illustrates two views of the cartridge, showing the position of a memory device;

Figure 9 illustrates schematically a device for writing data to the memory device;

Figure 10 illustrates an external reader, and

Figure 11 illustrates schematically the interaction of the reader with a memory device of the data cartridge.

Referring to the drawings, and to figure 1 in particular, a controlling software application on a host system 8 controls the operation of a tape drive 2 which reads data from and writes data to a tape data storage cartridge 4 comprising a tape 4a housed within a casing 4b. The host system typically comprises a computer 8 (main frame or PC) including at least one central processing unit (CPU) and at least one memory.

The back up software application controls the tape drive 2 through either operating system device drivers, or via the back up application's own software device drivers. Both methods of controlling the tape drive are known to those skilled in the art.

The tape cartridge 4 may be read by means of an external reader 6, shown in figures 10 and 11.

In the preferred embodiment the drive 2 is connected to the host system 8 by means of a Small Computer Systems Interface (SCSI) bus 7 or a USB (Universal Serial Bus). A SCSI bus serves to connect peripheral devices (such as

tape drives) to a computer via a SCSI controller. The method of communication over either of these standard busses is known to those skilled in the art.

The memory device 3 of the tape cartridge 4 has non-volatile storage capabilities such as EEPROM (electronically erasable programmable read only memory), with memory address space allocated for codes in the form of either signatures, or checksums, or CRCs (cyclic redundancy checks) corresponding to each set of data written to the tape. The memory device 3 has associated therewith a reader/writer device 50 for reading data from and writing data to the memory device 3.

A transmitter/receiver module 50 is incorporated into a tape drive mechanism such that when a tape cartridge is inserted into the tape drive mechanism, a transponder memory device 52 incorporated within the data cartridge can be inductively powdered, and data signals can be received and sent between the transmitter receiver 400 on the tape drive and the transponder in the tape cartridge.

The tape drive transmitter/receiver 50 comprises: a serial interface 54 to the tape drive; a processor 56; a transmitter 58; a receiver 60; a first aerial 62; and a crystal oscillator 64. The memory device 3 comprises a memory area 3a which may be an electrically erasable programmable read only memory (EEPROM) and a transponder 52 consisting of a transmitter 66; a receiver 68; an aerial 70; a processor 72 and a crystal oscillator 74; the reader/writer device 50 and the transponder 52 exchange information using a contactless interface via aerials 62 and 70.

This contactless interface uses inductive coupling employing a magnetic field to transmit data to/from the transponder 52, and supply power to the transponder 52 and memory area 3a. A protocol used to transmit information via inductive coupling is the known MIFARE® system developed by Philips/Mikron as is currently employed in "smart" credit card technology used in personal banking applications. The main advantages and features of this system as used by the present invention include high reliability, an operating frequency of 13.56 MHz, and the ability to handle several data storage cartridges within an operating field of a single data storage device.

The signatures to be written to a signature area 11 of the memory 3 in accordance with embodiments of the present invention are proposed to take up 128 bytes per signature, and it is proposed that the maximum number of signatures is 16. The memory also preferably includes space 10 (the count field) in which to indicate the number of signatures written to the memory. The memory device such as a cartridge memory contains a flag, which is set in its manufacturing data, to indicate that it supports this signature capability. Such manufacturing data is typically information stored in the cartridge memory at the time of manufacture with details such as media vendor, brand name, capacity etc. The flag can be set either at the time of manufacture or upon the first insertion into the tape drive.

The external cartridge memory reader or tape drive may also include a message display device (such as an LCD display or equivalent) for reporting whether or not the

memory is capable of receiving signatures and/or the current number of signatures in the memory.

A new blank tape cartridge has no signatures in the signature area 11 of its memory 3 and the signature count field 10 is initialised so that the signature count is zero. Each time a signature is added to the signature area the signature count is incremented by 1, such that at any time the signature count indicates the total number of signature entries (see figures 2, 3 and 4) held within the signature area 11 of the memory 3.

The only way a signature entry can be deleted is by complete re-initialisation of the data cartridge (which completely destroys the data on the cartridge), for example by means of a full erase command sent to the tape drive containing the tape cartridge by the controlling software back up application. This command both erases the data on the tape and the contents of the cartridge memory, other than those created at the tape's time of manufacture.

Each new access to the tape, such as for example to append data to an existing data set, is treated as a new set of data and the signature count is therefore incremented by 1 and written to the memory, in order to be able to trace or prevent amendments.

The implementation of the features of each of the two preceding paragraphs is known to those skilled in the art.

As illustrated in figure 5 in flow chart form, to back up data by writing sets of said data to the tape, the tape

cartridge 4 is loaded into the drive 2 and the drive then reads the signature flag from the cartridge memory 3, the number of entries in the signature table 11 and the last signature entry (step 14).

The tape drive uses this information to recognise the type of medium installed (i.e. with or without signature capability) and to work out the number of entries still available for writing signatures, and reports these two items of information to the controlling software application on the host system.

If the number of entries already in the table is equal to 16, the tape is reported as being read only (step 20), to prevent any further entries being made to the tape. This is achieved by setting the appropriate flag in the tape's cartridge memory to report that the tape is read only, and also by setting the appropriate bit in the relevant mode page to indicate this status. In order to be able to report the tape as read only, the controlling back up application inquires of the drive as to the status of the tape. The controlling back up application reads that the tape within the drive is only capable of read-only accesses. Such inquiring and reporting steps are known to those skilled in the art.

If the number of entries is less than 16 the cartridge reports, by carrying out the same steps as just previously described, that the memory 3 is capable of receiving signatures and it will also report the total number of entries in the signature table 11. The capability of the memory to receive signatures is optionally displayed via its message display device.

At commencement of a back up session the controlling software application issues a reposition command to the tape drive (step 22) to indicate that a back up session is about to start (alternatively a write from BOM (Beginning Of Media) signifies that new signature calculation should begin).

The data set is then written to the drive and during this process a signature of the data set is created, either within the tape drive itself or by the controlling software application depending on the tape drive's capabilities (step 24). Such a signature may be, for example, a running cyclic redundancy check (CRC) usually based on 32 bits or greater, which is kept of the data and is written to the cartridge memory, by either the tape drive or the controlling application, upon completion of the data being written to the tape. This technique is already known to those skilled in the art of CRC generation.

Following writing of the data set to the tape, the drive is issued with a further reposition (or unload) command from the controlling software application and at this stage the signature created for the data set just written to the tape is written to the cartridge memory at the next free signature slot either automatically by the drive itself or by the controlling software application to a write flag value in the new mode page. The controlling back up application first checks to see if the tape drive is capable of generating the CRC. If it cannot generate the CRC then the back up application generates the CRC.

It is preferred that the drive generates the CRC (or signature) as such an arrangement would be less prone to software modifications.

At the same time the signature count is written to the cartridge memory 3 by the drive and automatically incremented by 1 (the mode page entries for this information are also updated to contain the new information) (Step 26).

Thus, by incrementing the signature counter each time data is written to the tape (whether that data is original or modified data), any re-write of a data set can be detected. If the controlling back up application generates the signature then the software limits the accesses to the cartridge memory to allow retrieval and new signature creation only, which prevents overwriting of a signature.

In figure 6, the procedural steps involved in carrying out a restore/validation operation are illustrated.

Following loading of the tape 4 to be validated/restored from into the drive 2, the drive reads the signature flag, the number of entries in the signature table 11, and the position of the last signature entry (step 28).

The tape drive uses this information to recognise the type of media installed and the number of entries available and reports this information back to the controlling software application on the host system via a mode page with the drive (step 30).

If the number of entries is 16, (step 32), the tape is reported as read only to prevent further entries being made to the tape (step 34). The tape drive reports, through being interrogated by the controlling back up application, if it is capable of signature creation via another flag on the same mode page as the information for the data cartridge. The back up application then decides how the CRC is generated, i.e. by the tape driver or back up application.

If capable of displaying messages, the drive will report that this is a cartridge with signature capability and will also report the number of entries in the signature table 11.

If the number of entries is less than 16 (step 32), the controlling application requests the drive to report the signature of the required data set to be restored or validated (step 36) and the tape drive complies with this request by reporting the requested signature and the appropriate signature counter value from the cartridge memory (step 38).

The controlling software application then issues a reposition command to the drive causing it to reposition to the start of the required data set. If the tape drive is itself capable of signature generation it will generate a signature for this data set as it is read back from the tape, this new signature being reported back on the signature mode page as another flag value for data read from tape. (Steps 40 and 42). If the tape drive is not itself capable of signature generation (it is preferred that it is), the controlling software application

generates the signature for the data set being read from tape. One advantage of the tape drive generating the signatures is that the system would then be less prone to software modifications. However, this does not preclude the software generating the signatures for tape drives that do not support the CRC generation capability.

At the end of reading back of the data set, the signature generated by either the tape drive or the controlling software application is compared with the original signature stored during writing of that data set (step 44). If they agree then the data is unaltered and hence valid (step 48), but if they do not agree then the data is considered to have been altered or tampered with and therefore not valid (step 46).

Thus, with an external cartridge memory reader device which has a connection (physical or virtual) with the computer system and the controlling back up application, the signatures and number of entries on tapes can be examined and compared against information on a secure database (if they do not agree then the tape is assumed to have been tampered with or altered), thereby avoiding the need for the tape to be loaded and restored or read in order to determine if new data has been written to the tape.

Such a device 6 is shown in figure 10, and comprises a casing 76 having means 78 for receiving a tape data storage cartridge in the form of a port arranged to locate a cartridge; a display device, preferably a liquid crystal display 80; a user input interface 82 having a finger operable keypad; a battery power supply; a receiver device

for communicating with a memory storage device on a tape data storage cartridge, the receiver device being located in or near the cartridge port; and an external port 84 for connecting to an external computer device or processor.

Referring to figure 11 herein, there is further illustrated schematically components of the reader device 6, configured for reading, and displaying data from a transponder 52 having a read/write memory 3a and an aerial 70 in a tape data storage cartridge 4.

The reader device comprises an aerial 86, a receiver 88, a processor 90, a programmable memory area 92, a control interface 94, a display 80, a Read Only Memory (ROM) 96 containing an operating system, and a keypad 82 for entering instructions from a user. Interface 94 is capable of unloading to or down from an external device 98 having a processor.

The processor 90 has a relatively small amount of separate memory 92 of the order of 1 MByte or less, and is limited practically by the smallest size of memory chip commercially available. Alternatively, the processor 90 may be constructed integrally with memory area 92 on a same chip, for example a known Power PC® chip.

The aerial 86 and receiver 88 are used to receive data from the memory device 3 of the cartridge, which uses an electrically erasable programmable read only memory (EEPROM) as read/write memory area 3a. With the data storage cartridge inserted in the reader device, the aerial 70, of the memory device, forms a contactless interface with the aerial 86 of the reader device using an

inductive coupling scheme using a magnetic field to transmit data to the receiver 88. Such a scheme may be the protocol used to transmit information by the inductive coupling scheme is known as the MIFARE® system developed by Phillips/Mikron of the type presently employed in "Smart" credit card technology for use in personal banking applications and which is known in the art. Advantages and features of this system as used by the first embodiment include a high reliability; operating frequency 13.56 MHz; and an anti-collision protocol, which provides an ability to handle several transponders in close proximity without interference.

Aerial 86 of the reader device is positioned such that when a tape cartridge having a cartridge aerial 70 is positioned in the cartridge receiving means 78 of the reader device 6, the two aerials are positioned a distance less than or equal to 20mm from each other, so that inductive coupling can occur between the two aerials. Over such a range this yields coupling factors between aerials of the order 1 to 10% and transmission speeds of the order 100 Kbps between the aerials. Receiver 88 of the reader device transmits an inductive signal which is received by the transponder 52 of the tape cartridge, and which powers the transponder memory storage device 3 in the tape cartridge, such that the transponder is able to emit signals describing the content of the memory storage area 3a across an air gap between the two aerials, which is received by receiver 88. Alternatively, transmission of data signals between the memory device 3 and the reader device 6 may be within the infrared range of frequencies.

Data read from the memory device 3 in this manner is written via the processor 90 to programmable random access memory, RAM 92, where a copy of all read data is maintained. Data stored in the RAM 92 is displayed on the display screen 80 or is accessed via external processor 98 using the control interface 94.

The invention is not restricted to the details of the foregoing embodiments.

CLAIMS

1. A method of protecting data during writing of the data to a data storage tape, the method including the steps of:-

writing a data set to the tape and creating a code representative of the content of the data set being written to the tape, and

associating said code with said data set.

2. A method according to claim 1 and including the step of storing the code.

3. A method according to claim 1 or claim 2 wherein the code is stored by being written as an entry to a memory.

4. A method according to any of the preceding claims wherein the code is associated with the data set by allocating an identification symbol to said code.

5. A method according to claim 4 when dependent on claim 3, wherein said identification symbol is also written to the memory.

6. A method according to any of claims 3 to 5 wherein the memory is incorporated within a memory device.

7. A method according to any of claims 3 to 5 wherein the memory is a dedicated area of tape set aside for this purpose.

8. A method according to any of the preceding claims wherein at least said data writing and code-with-data associating steps are repeated to produce on the tape a number of data sets, each having a unique code associated with that particular data set.

9. A method according to claim 8 wherein each access to the tape is treated as a new data set.

10. A method according to claim 4 or claim 5 wherein the identification symbol is the number corresponding to the position of a particular code entry within a sequence of such code entries.

11. A method according to any of the preceding claims wherein the method includes the further steps of:

reading back a data set from the tape and creating a further code representative of the content of the data set read back from the tape,

comparing the two codes and confirming the data set as valid only if the two codes agree.

12. A method according to any of claims 8 to 11 wherein at least the codes created during writing of the data sets to the tape are written as entries to a table in the memory, in which each entry is identified by its position within the table.

13. A method according to any of the preceding claims wherein said code is a signature.

14. A method according to any of claims 1 to 12 wherein said code is a checksum or a CRC (cyclic redundancy check).

15. A method according to any of claims 6 to 14 wherein the memory device is a cartridge memory.

16. A method according to any of claims 4 to 15 wherein said identification symbol is numeric.

17. A method according to claim 16 wherein said identification symbol is an integer.

18. A method according to any of claims 8 to 17 wherein each time a data set is written to the tape and a corresponding associated code is written to the memory, the next code representative of the next data set is entered as the next entry to the memory.

19. A method according to any of claims 8 to 18 wherein there is included the step of keeping count of the total number of codes written to the memory.

20. A method according to claim 19 wherein there is included the step of checking whether or not a predetermined number of entries has been exceeded, and if it has, reporting the tape as read only.

21. A method according to claim 20 wherein said predetermined number of entries is 16.

22. A method according to any of claims 1 to 10 wherein there is included the steps of:-

comparing the associated code with information held on a secure database, and

confirming the tape and/or the data contained thereon as valid only if the code and its association with a particular data set agree with the information held on the secure database.

23. A method according to claim 22 wherein said information held on the secure database includes a secure copy of the code.

24. A method of protecting data during writing of the data to and reading of the data from a data storage tape, the method including the steps of:-

writing a data set to the tape and creating a first code representative of the content of the data set being written to the tape,

associating said first code with said data set,

reading back a data set from the tape and creating a second code representative of the content of the data read back from the tape, and

comparing the first and second codes and confirming the data set as valid only if the two codes agree.

25. A method according to any of claims 22 to 24, or a method according to any of claims 11 to 21, wherein the

comparing and/or confirming steps are carried out by a controlling software application.

26. A method according to any of claims 22 to 24, or a method according to any of claims 11 to 21, wherein the comparing and/or confirming steps are carried out by means of an external reader which is able to access and/or display information recorded in the memory.

27. A method of protecting data during writing of the data to a data storage tape, the method including the steps of:

writing a data set to the tape and creating a code representative of the content of the data set being written to the tape,

associating the code with the data set,

comparing the associated code with information held on a secure database, and

confirming the tape and/or the data contained thereon as valid only if the code and its association with a particular data set agree with the information held on the secure database.

28. A method according to any of claims 11 to 27 and including the step of storing the code.

29. A method according to claim 28 wherein the code is stored by being written as an entry to a memory device.

30. A method according to any of claims 27 to 29, wherein the information held on the secure database includes a secure copy of the code.

31. A method according to any of the preceding claims wherein the or each code creating step is carried out by apparatus used to write to and/or read from the tape.

32. A method according to any of claims 1 to 30 wherein the or each code creating step is carried out by a controlling software application.

33. A data storage tape having recorded thereon at least one data set, wherein said data set has associated therewith a code representative of the content of said data set.

34. A tape according to claim 33 wherein said code is stored as an entry to a memory.

35. A data storage tape arranged such that a data set recorded thereon may be associated with a code representative of the content of said data set.

36. A tape according to claim 35 wherein said code is stored as an entry to a memory.

37. A tape according to any of claims 33 to 36 wherein the code is associated with a particular data set by means of an identification symbol.

38. A tape according to claims 34 to 37 wherein the memory is incorporated within a memory device.

39. A tape according to claim 38, wherein the memory device has stored therein a number of codes, each representative of a particular one of a number of data sets on the storage medium and identifiable as associated with that particular data set.

40. A tape according to claim 39 wherein the codes are written as entries to a table in the memory device, in which each entry is identifiable by means of its position within the table.

41. A tape according to any of claims 33 to 40 wherein the code is a signature.

42. A tape according to any of claims 33 to 40 wherein the code is a checksum or a CRC (cyclic redundancy check).

43. A tape according to any of claims 38 to 42 wherein the memory device is a cartridge memory.

44. A tape according to any of claims 37 to 43 wherein the identification symbol is numeric.

45. A tape according to claim 44 wherein the identification symbol is an integer.

46. A tape according to any of claims 38 to 45 wherein the memory device includes a counter which indicates the number of codes entered.

47. A method of protecting data substantially as herein described with reference to the accompanying drawings.

48. A data storage tape substantially as herein described with reference to the accompanying drawings.

ABSTRACT

METHOD AND APPARATUS FOR DATA PROTECTION

A data storage tape 4 has an associated memory device 3 in which is stored a number of signatures 12 each representative of and associated with a particular data set recorded on the storage medium. By comparing the signatures against either signatures created during reading of the data sets back from the tape or against reference information held on a secure database any tampering or alteration of the data on the storage medium can be detected.

(Figure 4)

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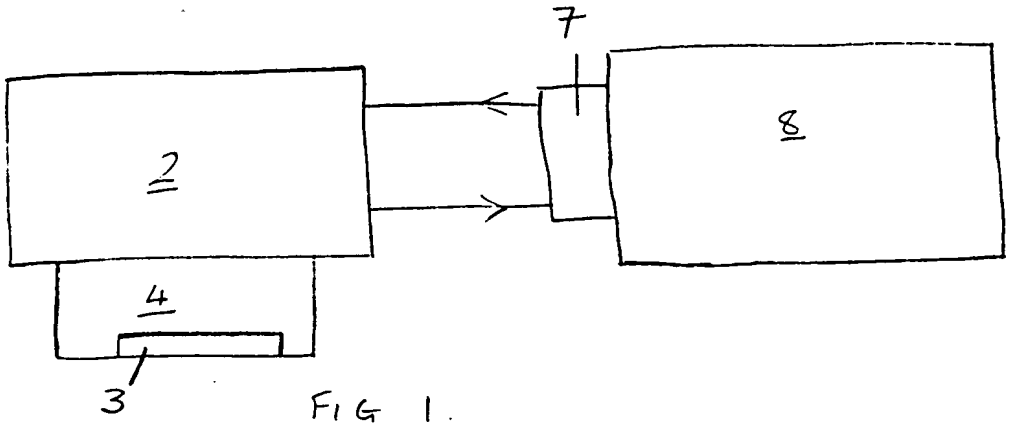

FIG 1.

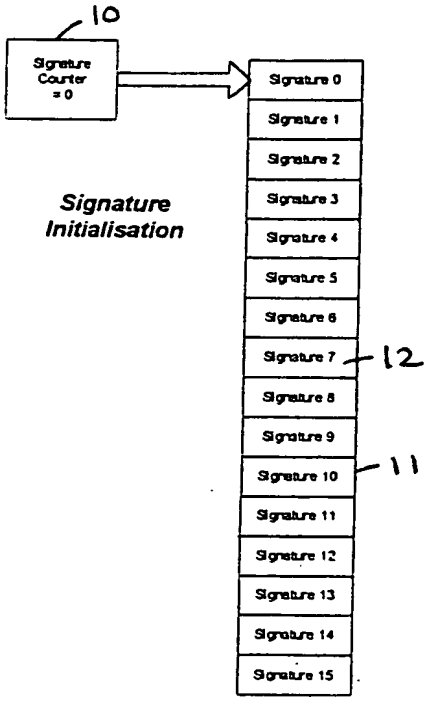

FIG 2

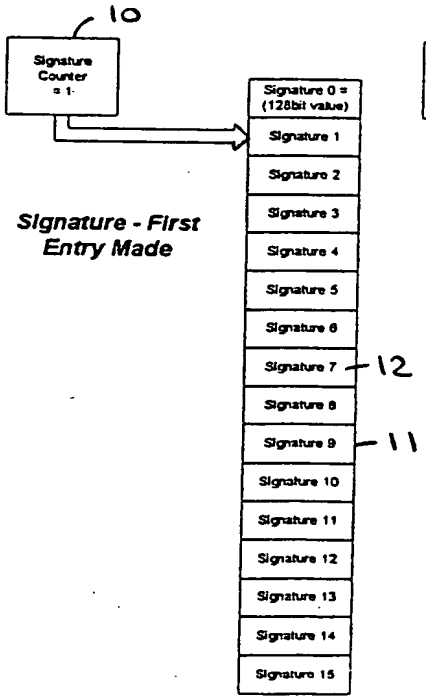

FIG 3

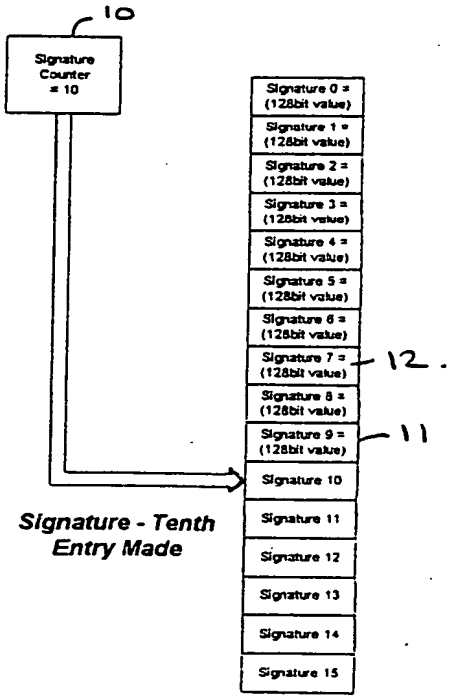

FIG 4

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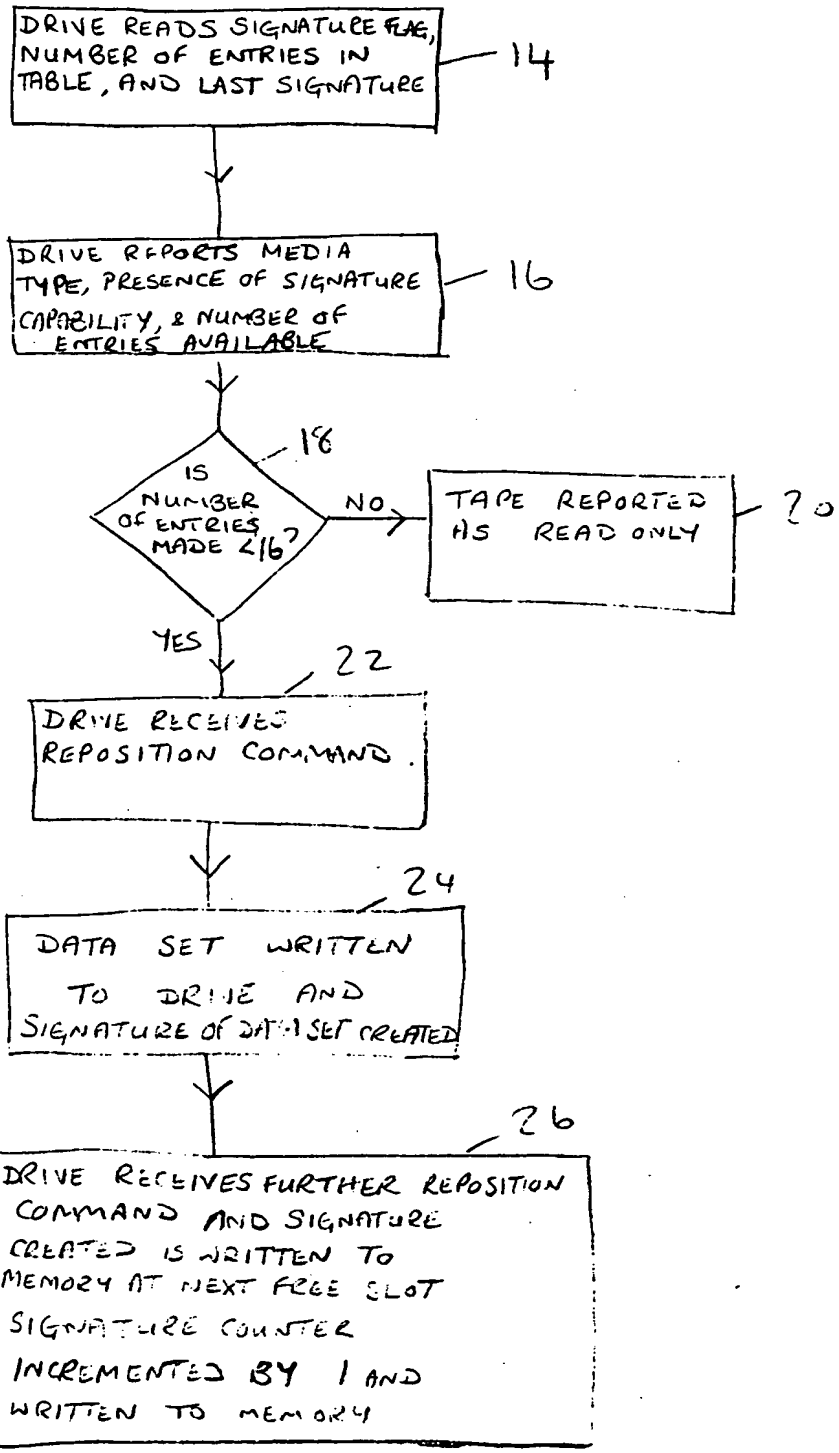

FIG 5

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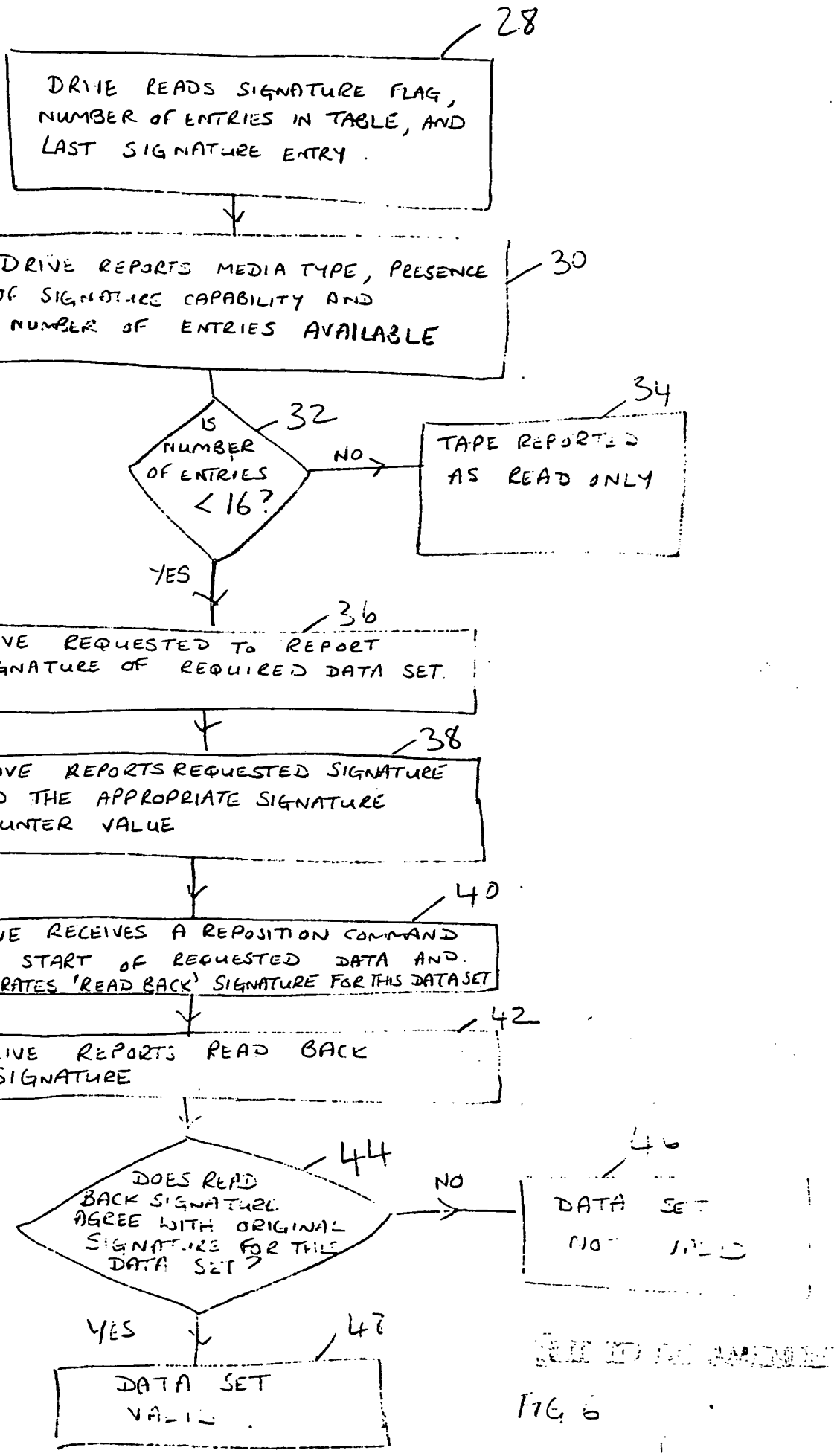
28
DRIVE READS SIGNATURE FLAG, NUMBER OF ENTRIES IN TABLE, AND LAST SIGNATURE ENTRY.
DRIVE REPORTS MEDIA TYPE, PRESENCE OF SIGNATURE CAPABILITY AND NUMBER OF ENTRIES AVAILABLE
30
IS NUMBER OF ENTRIES < 16?
32
NO
TAPE REPORTED AS READ ONLY
34
YES
DRIVE REQUESTED TO REPORT SIGNATURE OF REQUIRED DATA SET
36
DRIVE REPORTS REQUESTED SIGNATURE AND THE APPROPRIATE SIGNATURE COUNTER VALUE
38
DRIVE RECEIVES A REPOSITION COMMAND TO START OF REQUESTED DATA AND GENERATES 'READ BACK' SIGNATURE FOR THIS DATA SET
40
DRIVE REPORTS READ BACK SIGNATURE
42
DOES READ BACK SIGNATURE AGREE WITH ORIGINAL SIGNATURE FOR THIS DATA SET?
44
NO
DATA SET
46
YES
DATA SET VALID
47

FIG 6

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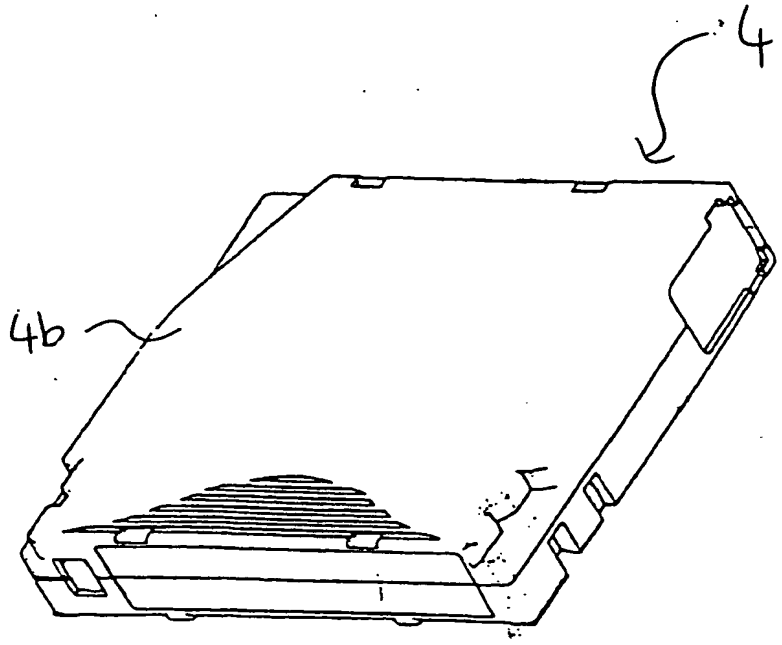

FIG7

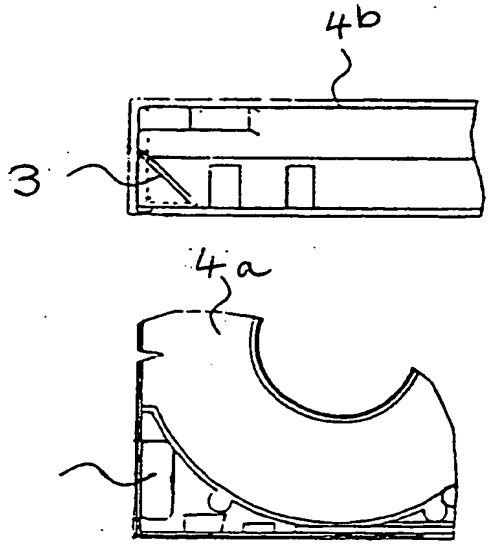

FIG8

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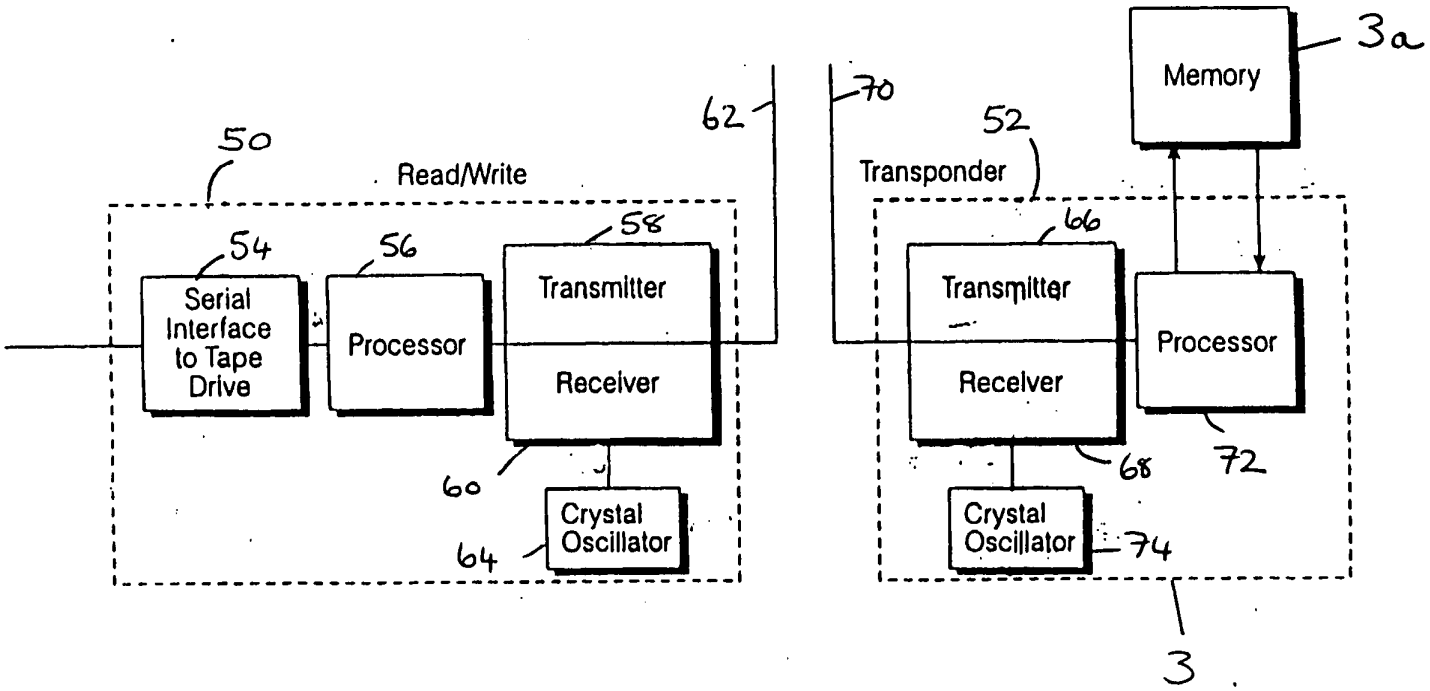

FIG 9.

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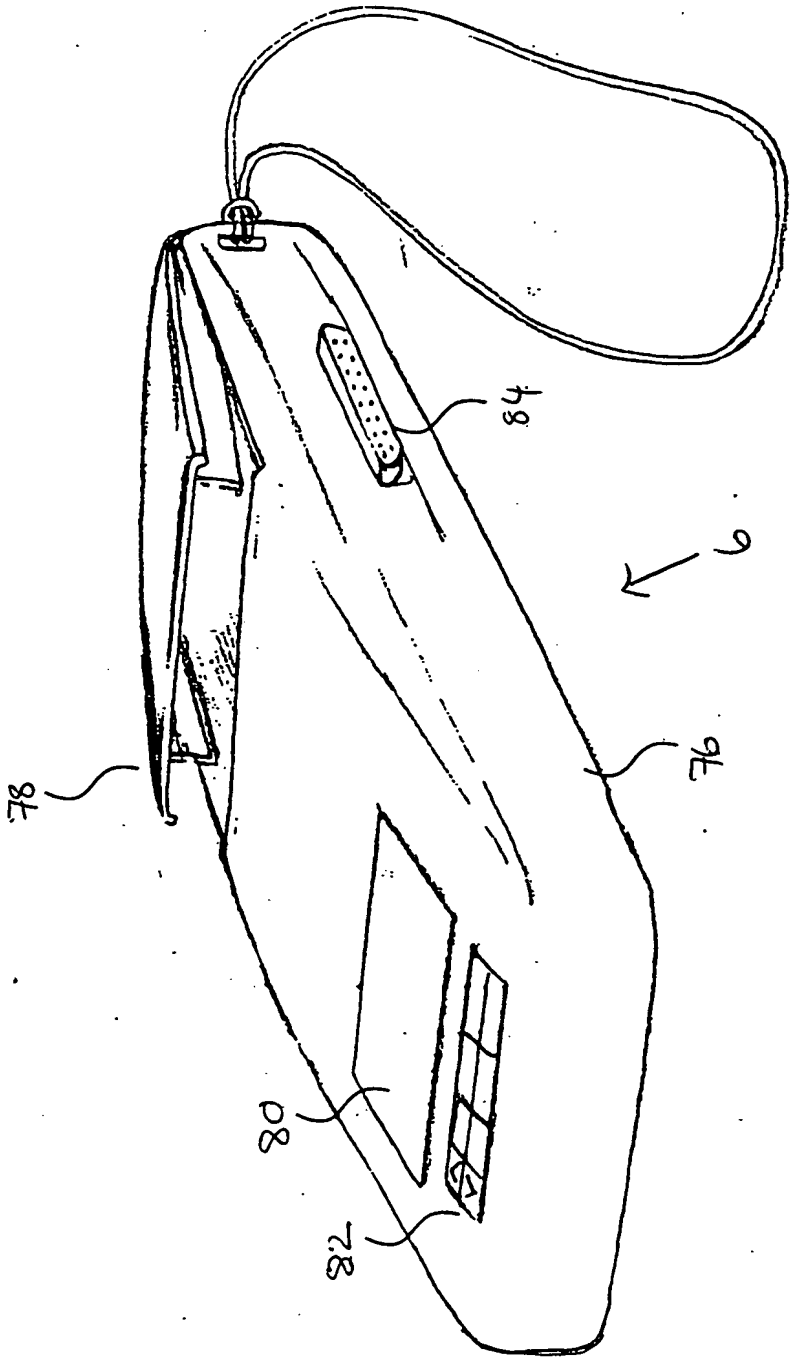

FIG. 10

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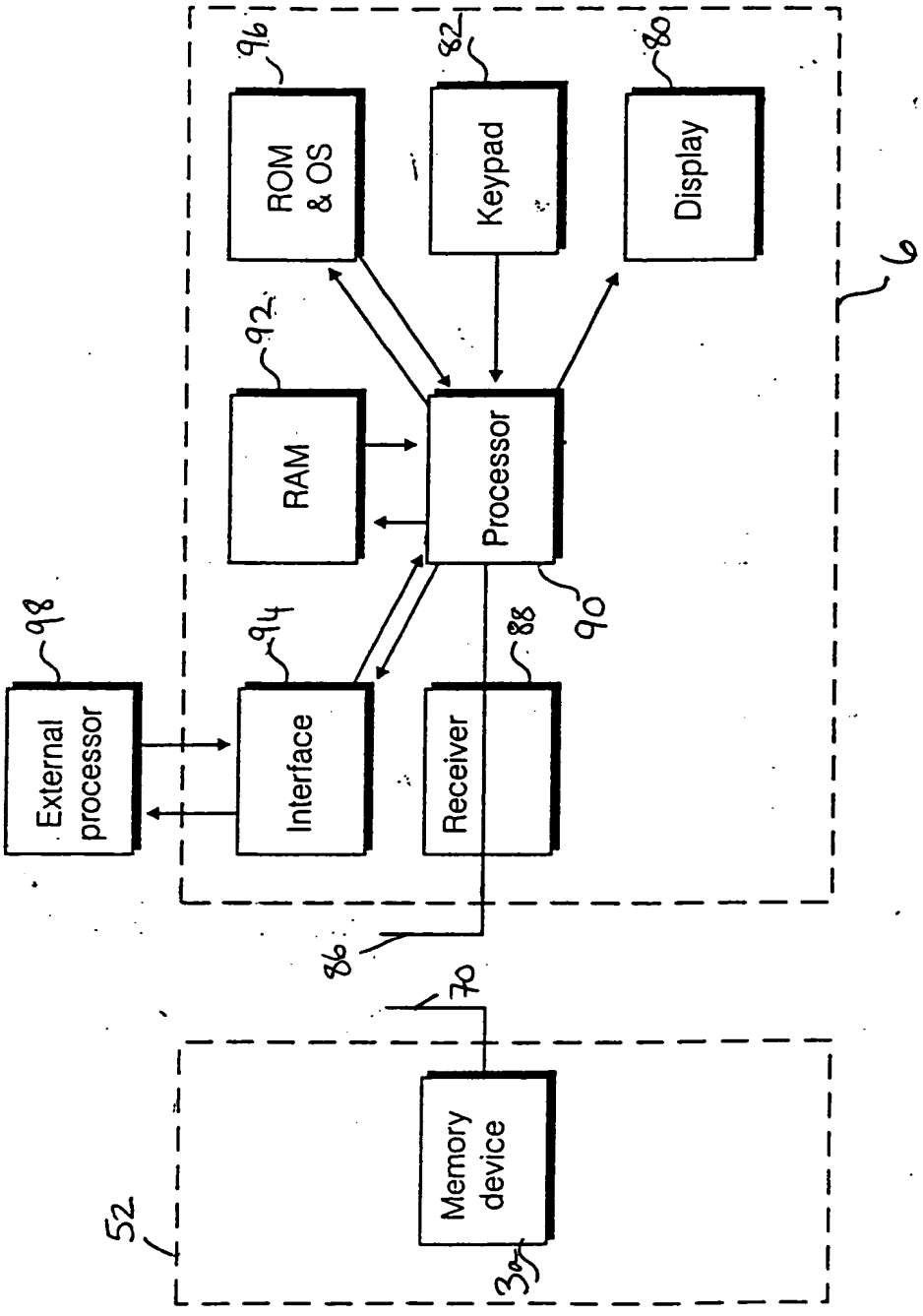

FIG 11.

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